# INFORMATION TECHNOLOGY, COMPUTER SCIENCE, AND MANAGEMENT

UDC 621.75.04 / UDC 621.91.04 / 004.9 https://doi.org/10.23947/1992-5980-2020-20-1-106-111

## Distinction between concepts of “structural-functional-parametric model” and “parametric model” of information knowledge objects

**E. N. Kolybenko**
Don State Technical University (Rostov-on-Don, Russian Federation)

*Introduction.* Fundamentally important problems of the structure mapping and transformation, functions and parameters of various properties in the systems of information knowledge objects organization, as well as functionally different parameters in the management processes of transformations of material objects, are considered. For this purpose, structural-functional-parametric models and parametric models are respectively used. The distinction between these concepts is relevant and practically significant. The scientific novelty of the presented work involves studying methods and information tools used to determine functionally different technological schemes for the interaction of objects at the stages of design and pre-processing engineering.
*Materials and Methods.* The concept of a “structural-functional-parametric model” is associated with the definition of the structure of the basic knowledge objects of the subject area. In this case, the “linking base” is the methods and corresponding means of system engineering in the infological modeling technology that are used to solve practical problems. The concept of a “parametric model” is associated with the solution to practical problems of the process control. Nature of these tasks is functionally different (technical, physical, chemical, biological). It should also be clarified that, in this case, we are talking about converting the parameters of various properties of real objects by methods and means of system engineering (almost a mathematical apparatus).
*Results.* A “structural-functional-parametric model” and a “parametric model” are general theoretical concepts that have invariant properties necessary for solving practical problems of the subject knowledge area. Considering the organization system and management processes in this way, note that it is required to maintain data and logical connections between them under static and dynamic settings.
*Discussion and Conclusions*. To solve practical problems in the subject knowledge area according to the technology of information logical modeling, certain methods, tools, algorithms, and operations are used. The most complete mapping and transformation of information objects is possible only in structural-functional-parametric models and databases of their solutions. The application of structural-functional-parametric models is the most important condition for a successful transition to a high-level deterministic automation of information technology for solving practical problems of the subject area. As an example of such a problem, we can cite the machining production design engineering.

***Keywords:*** production design engineering, cutting, system analysis, information technology, decision modeling, system technique.

***For citation:*** E. N. Kolybenko. Distinction between concepts of “structural-functional-parametric model” and “parametric model” of information knowledge objects. Vestnik of DSTU, 2020, vol. 20, no. 1, pp. 106−111. https://doi.org/10.23947/1992-5980-2020-20-1-106-111



**Introduction.** The development of systems engineering allows us to distinguish between the concepts of “parametric model” and “structural-functional-parametric model” taking into account the properties of the concepts of “mathematical modeling” and “logical modeling”, as well as the functions of their knowledge [1, 2]. Systems engineering technology for determining the structural-functional-parametric model is based on the formalization of domain knowledge. Formalized concepts are first built into the structure of the basic knowledge objects, and then into the structure of basic knowledge objects of a higher level of the subject area. At this, the semantic and syntactic properties of the concepts [3] should be as strict as possible. In this case, the author’s updated interpretation of existing and new concepts is fundamentally important. By actualization, we mean activation, initialization of meaning by transferring from a static (outdated) state to a dynamic (updated) state while preserving all the necessary links and relationships within the system

and with the external environment. This approach to the formalization of knowledge of the subject area provides for its transfer to a higher level of organization.

We introduce the updated concept of "system principles". These are information logical statements of the approach to solving the problems of researching manufacturing systems and processes of functionally different purposes. These principles are verified by the multiple practice of their use in the setting environment (static – for systems and dynamic – for processes).

**Materials and Methods.** We formulate system principles.

1. Information structural-functional-parametric and parametric models are investigated. The distinction is based on two system principles:

- unity and generality,
- difference.

Let us compare the structural-functional-parametric models of information objects and the parametric models of real objects.

Their unity and generality are manifested in the functions of destination under the computer processing of information: display, transformation, storage, transmission.

The difference is manifested in the methods and means of solving practical problems of the subject domain defined in the considered models.

Technologies for determining structural-functional-parametric models are implemented by methods and systems engineering tools: systems theory, systems analysis of decision making, set theory, and graph theory.

Set theory uses graphic means: formalized notation of concepts, logical operators for making statements by imposing links between formalized concepts.

Graph theory specifies overlays, intersections, and associations of links between functionally unified elements of the object structure according to the semantic and syntactic properties of the formalized concepts used. To this end, structure graphs and Venn diagrams are used.

To determine the algorithms in the technology of modeling systems for organizing information objects, conceptual notions are used: mapping, transformation, structure, set, etc.

In the practice of solving problems, systems engineering technologies are widespread. They are used in the processing of information on computers and servers (that is, in computer systems), as well as in the management of functionally different organization systems.

In [4], systems engineering technology is presented as system technique technology. This significantly narrows the scope of its application. The paper [5] can be recommended for information on the methodology of systems engineering in information technology for identifying large, sophisticated powerful systems in solving practical problems.

Technologies of system techniques are implemented by various mathematical methods and means. With their help, parametric models, based on the mapping and transformation of the parameters of various properties of real objects, are determined. In the parametric models, processes of controlling the transformation of real objects within the corresponding domain organization systems are mathematically modeled.

The authors of [6] investigate the solution to problems of the practice of manufacturing preparation of machining production. Here is an example of significant difficulties that arise under the implementation of this task by modern means of the mathematical apparatus on an insufficiently formalized reference basis of knowledge.

In [7], the practice of successful implementation of the systems engineering technology in functionally different management is described. In [8–13], various approaches to systems engineering technology for solving problems of controlling the mathematical apparatus are considered. The papers [14–15] providing for determining the state of the manufacturing preparation knowledge, are directly related to solving the problems of its practice.

**The purpose-oriented properties of the "structural-functional-parametric model" concept and the knowledge functions following from its formulation.** In the further presentation of the material, we use the updated concepts introduced in [1]:

- structure,

- main structure elements (integration, disintegration),
- design quality of the main elements (integration, disintegration) in the structure of objects {components} of the DPP stage and the structure of objects {initial blanks} of the PPE (TO) stage,
- basic object of knowledge,
- information "slave" (main) transformation object (TO).

The concept of "structure" will be considered in various aspects on the example of manufacturing preparation of machining production.

We introduce the formalized notation of concepts:

- DPP is the stage of designing preparation of production,
- PME (TO) is the stage of preproduction machining engineering,
- {…} is multitude.

1. Consider the well-known judgment: "Everyone sees the material, the content is found only by someone who has something in common with it, and the form remains a mystery for most … The form needs to be digested as well as the material, but it is much more difficult to digest"[1].

Between the elements of knowledge in the triad of cognition, the sequence of their link (material $\Rightarrow$ content $\Rightarrow$ form), since the content can change depending on the perception of the material, and for the same content the form of its display can change.

In most cases, knowledge is developed through transforming their display form, which determines the level of achievement of their depth and changes accordingly. A necessary condition for the transition from the knowledge content to the form of their display is the achievement of a certain level of combining concepts into a system.

2. A single environment of one level of the structural elements of the "slave" transformation object, in a general case, interacts (is interfaced) with a group of structural elements of the "leading" object. This interaction is provided by the imposition of functionally different relationships along the "reference" interface points from the side of the "leading" object structure to the structure elements of the coordinate systems of the "slave" object. It is on this coordination that structural-functional-parametric models are based.

3. The connection of the "slave" and "leading" objects of interaction enables to introduce the following concepts to define the concept of "structure" of basic knowledge objects:

- composition of the structural elements,
- type of working (functional) connection,
- communication overlay method,
- functions of working relationships,
- parameters of the properties of structural elements and the relationships between them.

4. The connection of objects is based on the system principle formulated in [16]: "The boundaries of their connection carry the greatest information about sets". The structural elements of each of the interaction objects, determined by the boundaries of their connection, are functionally new. In this case, the tasks on determining the position of the elements in the coordinate system of the "slave" object are solved. This connection of objects is used to determine the structure of the basic knowledge objects of any subject area.

5. The existence of the structure of the base knowledge objects is provided only by those initial (previously defined) and obtained new concepts that can be defined as formalized (symbolic properties of concepts [3]), as well as unified analogues of structural elements and the relationships between them, to be embedded in the structure.

6. The main first and second base knowledge objects of the first type of the PME (TO) stage are specified in the corresponding two process charts for the interaction of "slave" objects according to the working functions performed by them (basing, geometric shaping of the form element).

7. The main base knowledge object of the fourth type of DPP stage is determined by the type of the main first base knowledge object of the first type of PME (TO) stage in the corresponding process chart of the interaction of ob-

[1] Gete IV. *Ob iskusstve* [On art]. Moscow; 1975. 623 p.

jects. In the structure of objects {components, assembly units} of the DPP stage, it is possible to identify three more "slave" objects according to the work functions performed by them (basing, guides, torque transmission, division and fixing) [17].

8. The scientific novelty of the presented paper involves studying methods and information tools used to determine functionally different process charts for the interaction of objects of the PME (TO) and DPP stages.

9. The information technology for the automated solution to the PME (TO) tasks assumes that the most important condition is met — the definition of two "slave" transformation objects as components in the structure of the {initial blanks, blanks} of the PME (TO) stage and in the general case of four "slave" transformation objects as an integral part in the structure of objects{components, assembly units} of the DPP stage.

10. The model information of the main base knowledge objects of PME (TO) is distributed in two parts: invariant and typical object-oriented parametric ones. They are logically unified and cannot be considered separately.

The invariant parts of the information model structure of the main base knowledge objects at the PME (TO) stage are designed to solve the problems of optimizing material and labor resources in the main and auxiliary technological operations. Typical object-oriented parametric parts of these main base knowledge objects serve as the basis for determining the base knowledge objects of a higher level of the subject area of the PME (TO).

11. Each of the two parts in the structure of information models of the main base knowledge objects is determined by the form of display (graphic in two-dimensional space, the corresponding analytical in three-dimensional space). This provides the conditions for the automated conversion of the form of their display from one view to the corresponding another and vice versa.

12. The information content and form of the base knowledge object can be determined due to its structural-functional-parametric information model for displaying and transforming the algorithm into technology for solving practical problems of the subject knowledge area from input to output under computer processing. Such information is perfect.

13. The main base knowledge objects (of the fourth type of the DPP stage, of the first and second types of the of the PME (TO) stage) form a systemic fundamental for the hierarchical structure of the knowledge base of the PME (TO) stage according to the seven levels of classification of its base objects of various types. Base knowledge objects of all types are defined in the contours of the coupling circuit of their structure elements according to the superimposition functions (relations, links) of the structure elements in the totality of logically and information-related coordinate systems. The fundamental of the knowledge base structure of the PME (TO) stage is made up of elementary and composite superimposed simple and complex functionally different{elements of geometric shape}. These {shape elements} are used primarily to determine the elements in the structure of the group of objects of interaction of functionally different flowcharts, and secondly – to determine elements in the structure of the main base knowledge objects of the first and second types of the PME (TO) stage, as well as of the fourth type of the DPP stage. The first first-type base knowledge object of the stage is {basing flowcharts} on their possible set for fulfilling the functions of basing production objects and cutting tools into machining attachments, as well as the devices — into the corresponding working bodies of the cutting machine. The second first-type base knowledge object is {basing flowcharts of the shape elements into working machines and geometric formation shape elements by cutting on working machines} on their possible set. The second-type base knowledge object is {working machines} as an information and logical connection of the first first-type base knowledge object in a general case with a limited necessary set of the second first-type base knowledge objects. The third-type base knowledge object is {working machine systems} as an information and logical connection of the fourth-type base knowledge object of the DPP stage in a general case with a limited necessary set of logically and information-related second-type base knowledge objects of the PME (TO) stage. The fourth-type base knowledge object of the DPP stage is {basing flowcharts} on their possible set for fulfilling the basing functions for parts and assemblies into design products. The fifth-type base knowledge object of the DPP stage is {design products}.

**Research Results.** In the paper presented, structural-functional-parametric models of functionally different types are used to determine the hierarchical structure of the knowledge base of the PME (TO) stage at seven levels. The

structure of the hierarchical knowledge base of the PME (TO) is determined from the results of extensive practice of cooperation with metalworking enterprises. This is the most complete structure of the composition of the elements and relationships between them. It has invariant properties with respect to a possible set of subject knowledge areas for its distribution, for example, pressure, welding, computer processing of information, management.

**Discussion and Conclusions.** The hierarchical structure of the knowledge base of the PME (TO) subject area is grounded on:

- structural-functional-parametric models of the main base knowledge objects of various types;
- databases formed on a possible set of model solutions.

Base knowledge objects of all types are distributed among the levels of the knowledge base structure. These objects are connected through an organic unity of the design quality parameters of the main elements (integration, disintegration) of their structure [1], which makes their separate consideration impossible.

The solution to practical problems in the invariant parts of the structure of information models for the main base knowledge objects provides for an adequate calculation of the material and human resources needed to optimize the design and organization of the CKD production.

The solution to practical problems in typical object-oriented parametric parts of the structure for information models of base knowledge objects of all types provides for the design quality of the basic elements (integration, disintegration) of the structure of "slave" transformation objects.

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Submitted 13.01.2020
Scheduled in the issue 02.03.2020

*About the author:*

**Kolybenko, Evgenii N.,** Leading Research Scholar, Don State Technical University (1, Gagarin sq., Rostov-on-Don, 344000, RF), Cand.Sci. (Eng.), ORCID: https://orcid.org/0000-0003-1851-3885, e.n.kolybenko@mail.ru

*The author has read and approved the final manuscript*